SMALL RUMINANT PRODUCTION SYSTEMS

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Abstract *Small ruminant production systems in South and Southeast Asia and the South Pacific are primarily traditional systems. These can be classified into three main systems: extensive systems; systems combining arable cropping to include roadside, communal, and arable grazing systems, tethering, and cut and carry systems; and systems integrated with tree cropping. Of these, the systems integrated with tree cropping have not been exploited and, therefore, merit the highest priority. Within the production systems there exist 53.4 and 22.9% of the total population of goats and sheep in Asia, respectively, that have annual growth rates of 1-2%. The per caput goat meat supply is decreasing, whereas that of mutton is increasing. The value of ownership of these species is reflected in several advantages and include income, food, security, employment, fertilizer, social values, recreation, and by-product feed utilization. The traditional nature of these systems stems from secondary position of goats and sheep in mixed small farm systems, lack of incentives, and new innovations that do not stimulate production. The major constraints to the production systems are inefficient use of the goat and sheep genetic resources, management, diseases and health, and inadequate marketing outlets. This trend, if left uncorrected, is likely to continue. Potential improvements to the production systems are, therefore, urgently necessary, including the need for appropriate methodology that can make a significant and rapid impact on production. Expanding production for both species calls for major shifts in resource use and especially new innovations that are demonstrably more superior and consistently profitable.*

Ruminant production throughout South and Southeast Asia is at present a priority in livestock development programs. There

are three principal reasons. First, relative to the contribution by crops, ruminants have failed to keep pace with the increasing demand by humans, of food of animal origin. Second, compared with the larger, very intensive and more successful nonruminant pig and poultry industries found in urban fringe areas, ruminants, with few exceptions, have not demonstrated a parallel success. Third, there is the important point that among ruminants, goats and sheep are traditionally owned and serve a wide variety of functions in the preponderance of small farm systems that are characteristic of Asian agriculture involving several millions of small farmers, landless labourers, and peasants in essentially rural areas (Devendra 1983). Because of these reasons, it is appropriate to examine the nature of the production systems in the context of current and future contribution.

Small ruminant production systems form a component of farming systems (Duckham and Masefield 1970; Ruthenberg 1976; Spalding 1979). Although agroecological conditions determine the types of crops and livestock systems suitable to any one location, the prevailing ruminant production systems have evolved in response to the total availability of land, the type of crop production practiced, the frequency of cropping, the area of uncultivated wasteland, and the density of animal populations.

At present, within the developing countries, small ruminant production systems are primarily traditional. Part of the reason for this is because goats and sheep play a secondary role to crop production, have not received adequate research and development support, and are generally of low priority in animal production programs. A recent report by the World Bank (1983) concluded from an analysis of 80 research or development projects on a regional basis that there was a lack of support within the developing countries and international donor and lending agencies. Equally important, there have been few changes and improvements to encourage the creation of more efficient productive systems. In turn, this has resulted in little if any major shift toward the development of commercial production systems that are consistent with increased productivity.

The fact remains, however, that small ruminants play an important and contributory role to the stability of complex small farm systems such as those found in Asia (Devendra 1976, 1983). Attempts to improve the prevailing systems must necessitate a better understanding of the components of the

production systems, the present limitations, potentially feasible improvements, and the opportunities to develop more productive systems. This paper examines and discusses these aspects.

GOAT AND SHEEP POPULATIONS

Goats and sheep in South and Southeast Asia account for 53.4 and 22.9% of the total population of these species in Asia, respectively (Table 1). India has the largest goat and sheep population, accounting for 59 and 57%, respectively, of these species in South and Southeast Asia. Indonesia accounts for about 6% of both the goat and sheep populations of the region. The ratio of sheep to goats is 1:1.8. The rates of growth of the individual species over the last 10 years from 1974-76 to 1984 were 2.1 and 1.5% respectively, indicating that the goat population is growing faster than the sheep population in South and Southeast Asia.

Goats were responsible for 54.1, 53.8, and 57.6% of the total production of meat, milk, and skin in Asia, respectively. Also, sheep were responsible for 19.8, 1.4, 20.8, and 19.7% of the total mutton, milk, skin, and wool production, respectively, in Asia (Table 2).

Table 1. Goat and sheep resources of South and Southeast Asia.

Species	Population		Annual growth rate (%)	
	Total ($\times 10^6$)	% of Asian population[a]	1974-76 to 1984	% of total grazing ruminants in Asia
Goats	136.2	53.4	2.1	12.6
Sheep	73.0	22.9	1.5	6.8

Source: FAO (1984).
[a] Goats, 255.2×10^6; sheep, 322.9×10^6.

Table 2. The relative contribution of goats and sheep in South and Southeast Asia.

Product	Goats		Sheep	
	Production (t x 10^3)	% of total Asian production	Production (t x 10^3)	% of total Asian production
Goat meat	661	54.1	-	-
Mutton	-	-	353	19.8
Goat milk	1907	53.8	-	-
Sheep milk	-	-	52	1.4
Goat skins[a]	135891	57.6	-	-
Sheep skins[a]	-	-	73983	20.8
Wool (greasy)	-	-	89466	19.7

Source: FAO (1984).
[a] Actual production (fresh).

GOAT AND SHEEP GENETIC RESOURCES

Over the three periods 1961-1965, 1974, and 1984, the percentage proportion of carcass meat accounted for by goat meat was 3.9%; for mutton in the last decade, 5.6%. The per caput (per adult person) goat meat supply suggests that this is generally static (0.40-0.47 kg/year), but for mutton it is increasing (0.56-0.64 kg/year).

Table 3 identifies and summarizes the names of the more important goat and sheep breeds in South and Southeast Asia. Although 12 "improver" breeds are identified, this list is by no means complete. Each of these breeds has a specialty and the approximate adult live weight of the doe is also given. A number of these breeds, such as the Jamnapari, Beetal, and Marwari in India, and Damani, Dera Din Panah, and Kamori in Pakistan, are dairy breeds. There has been very little or no selection, however, for improved milk yields with all these breeds. Thus, their potential milk-yielding capacity is not very certain. The Fijian and Sirohi are outstanding meat breeds and respond to good live weight gains in efficient feeding systems. The Black Bengal and Malabar breeds from

Table 3. Important goat and sheep breeds in South and Southeast Asia.

Breed	Country	Speciality	Approximate adult live weight of female (kg)
		Goats	
Barbari	India	Milk, meat, prolificacy	27-35
Beetal	India	Milk	40-45
Black Bengal	India	Prolificacy	9-15
Damani	Pakistan	Milk	21-25
Dera Din Panah	Pakistan	Milk	40-42
Fijian	Fiji	Meat	30-35
Jamnapari	India	Milk	45-60
Kamori	Pakistan	Milk	50-55
Katjang	Malaysia, Indonesia	Prolificacy	22-23
Malabar	India	Prolificacy	40
Marwari	India	Milk	25-27
Sirohi	India	Meat	50-53
		Sheep	
Baluchi	Pakistan	Mutton	35-40
Chokha	India	Coarse wool	23-25
Indigenous Javanese thin tailed	Malaysia	Coarse wool	22-24
Priangan	Indonesia	Prolificacy, mutton	25-28
East Java fat tailed	Indonesia	Prolificacy, mutton	27-30
Jaffna	Sri Lanka	Hair	30-35
Lohi	India	Mutton, prolificacy	18
Mandya	India	Mutton	22-28
Nellore	India	Mutton	28-30
			38-42

India and the Katjang from Malaysia are prolific breeds, but, yet again, there has been no selection for this trait. The Barbari is a dual- or triple-purpose breed that has considerable potential for use in development programs.

Of the 10 sheep breeds identified in Table 3, the Nellore and Mandya from India and the Baluchi from Pakistan are good mutton breeds. With the exception of the Lohi breed in India, Indonesia has at least three outstanding prolific breeds in the Javanese thin-tailed, Priangan, and East Java fat-tailed goats. Although high variability in litter size has been noted, there are indications of a high repeatability of ovulation rate in the Boorola type (Bradford et al. 1984). These breeds are particularly valuable for improvement programs and in the multiplication of numbers. Two useful breeds for coarse wool production are the Chokla from India and the indigenous sheep in Malaysia (Devendra 1975). The sheep and goat breeds of Indian have recently been described by Acharya (1982) and of Pakistan by Hasnain (1985). Although many of the breeds have been described, their potential productivity remains largely unknown.

ECONOMIC IMPORTANCE OF GOATS AND SHEEP

An indication of the economic importance of rearing goats and sheep is found in detailed studies on the subject recently reported in Indonesia (Knipscheer et al. 1983). This study indicated that the involvement of rural households in West Java in raising small ruminants is large, that one out of every five farmers keeps sheep or goats, and participation by farmers can be as high as 30%. The estimated share of small ruminant income of the total income is indicated in Table 4. The contribution of the goat and sheep enterprise in the total farming income is substantial and was about 14, 17, and 26% for the three categories of lowland, upland, and rubber plantation situations, respectively. The report also indicated that the income share of the small ruminant enterprise increased as the farmer's resource base, especially land, decreased.

SIGNIFICANCE OF OWNERSHIP

Goats and sheep are raised with several objectives in mind. They serve the material, cultural, and recreational needs of the farmers. Their ownership has the following advantages:

- Income: important means of earning supplementary income.
- Food: provide animal proteins (milk and meat) that are important for the nutritional well-being of peasants.

Table 4. Estimated share of small ruminant income of total income in West Java, 1980.

Location	No. of farms surveyed	Annual income per farm (IDR)[a]	Small ruminant income	
			Total (IDR)[a]	% of annual income
Cerebon (lowland)	79	222000	37593	17.1
Ciburuy (rubber plantations)	66	180000	46671	25.9
Garut (upland)	135	300000	41466	13.8

Source: Knipscheer et al. (1983).
[a] In October 1986, 1625 Indonesian rupiah (IDR) = 1 United States dollar (USD).

- Security: sources of investment, security, and stability.
- Employment: creation of employment including effective utilization of unpaid family labour.
- Fertilizer: contribution to farm fertility by the return of dung and urine.
- By-product utilization: they enable economic utilization of nonmarketable crop residues.
- Social values: the ownership of animals has been shown to increase cohesiveness in village activities.
- Recreation: socioeconomic impact of animal ownership also includes a recreational contribution to small farmers.

The small size of the ruminants is a distinct advantage in the complexity of small-scale farm systems. There are definite economic, managerial, and biological advantages.

- Economic: low individual values mean a small initial investment and correspondingly small risk of loss by individual deaths. This makes goats and sheep an attractive proposition for household use and subsistence farming, especially for poor families.

- Managerial: goats and sheep can conveniently be cared for by women and children, occupy little housing space, and supply both meat and milk in quantities suitable for immediate family consumption, which is important in view of the difficulties of storage in the tropics.

- Biological: one or two goats or sheep can be kept when nutrition is inadequate for even one cow.

PRODUCTION SYSTEMS

Small ruminant production systems in South and Southeast Asia have endured in relation to the overall pattern of crop production and farming systems. They are especially dependent on the agroecological environment and, as ruminants, must always depend on vegetable or crops for their feed base. The reference to the agroecological environment is important because in the more arid regions, the sparse vegetation provides a weak feed resource base. For this reason, the small ruminant production systems are primarily nomadic and transhumant systems.

By comparison, in the humid tropics, which is characteristic of South India and most parts of Southeast Asia, feed resources are more abundant and, hence, sedentary systems that can also be intensive systems become possible. This also enables the more important crop and livestock systems to develop.

Table 5 brings together types and characteristics of predominant farm systems involving ruminants, including goats and sheep, in Asia. The table identifies the cropping pattern (wheat, rice, maize, or a combination of these; and cocunuts, oil palm, and rubber), type of ruminants reared, production objective, and gives approximate sizes of goat and sheep flocks. The latter are variable and partly dependent on the

Table 5. Types and characteristics of crop farm systems involving small ruminants in Asia.

Cropping pattern	Ruminants	Small ruminant production objectives	Average size of goat and sheep flocks	Current importance[a]
Rice	Buffalo, cattle	Goat meat, mutton	1-5	Low
Mixed rice-maize[b]	Cattle, buffalo, goat, sheep	Goat meat, mutton	1-5	Low
Mixed rice-wheat	Cattle, buffalo, goat, sheep	Goat meat, mutton, milk	10-30	Medium-low
Mixed rice	Buffalo, cattle, goat, sheep	Goat meat, mutton	1-5	Low
Wheat	Cattle, buffalo	Goat meat, mutton, milk	10-30	Medium-low
Wheat-rice	Cattle, buffalo	Goat meat, mutton	10-30	Medium-low
Coconuts	Goat, sheep	Goat meat, mutton	10-40	Medium-low
Oil palm	Buffalo, goat, sheep	Goat meat, mutton	8-30	Medium-low
Rubber	Cattle, goat, sheep	Goat meat, mutton	8-30	Medium-low

[a] Based on average ownership by small farmers, landless labourers, and peasants.
[b] Mixed crops refer to root crops, oil seeds, cash crops, vegetables, and fodders.

nature and extent of the crop residues produced. When mixed cropping is involved, the table also provides the types of crop grown. The last column of Table 5 gives an indication of the current importance of goats and sheep in each of the main systems, based on average ownership by small farms, landless labourers, and peasants. Asian livestock production and management systems have recently been described (Camoens 1985).

Small ruminant production systems can be classified as follows: extensive systems; systems combining arable cropping to include roadside, communal, and arable grazing systems, tethering, and cut and carry feeding; and systems integrated with tree cropping.

Extensive Systems

This system is by far the most common for all ruminants throughout the Asian region. It is characterized by small ruminants, usually owned by small farmers, grazing on all available grazing areas, largely uncultivated, including marginal land, for varying periods during the day. The length of the grazing period is dictated primarily by the type of ruminant and the objectives of production, i.e., meat or milk.

The system has certain very definite features. Rearing ruminants is secondary to crop production, consistent with the pattern of agriculture. Usually, more animals tend to be carried than in the intensive system, probably because these animals have access to plenty of grazing land. Buffalo and cattle tend to be grazed separately, but where goats and sheep are reared, these small ruminants are grazed together, probably because goats tend to lead the herd. Additionally, the small ruminants tend to be herded over longer distances compared to buffalo and cattle, which are relatively more sedentary.

The flock sizes are larger (1-15 herd), and animals, often goats and sheep belonging to several owners, are run together and brought back in the evening. Stocking rates are usually in the range of 1-4 head/ha. Very extensive systems are rare, as with other parts of the humid tropics, presumably because of the availability of more forage and crop residues.

In the extensive system, a low level of unpaid family income represents the main input. By implication, the use of this unpaid family labour, usually women and children, represents an aspect of effective labour use whereby both cropping and rearing of ruminants represent important components of farm

income. Except for the use of this low labour input, the system is principally one of low resource use, and a generally low level of productivity emerges from substandard nutritional management where very little or no concentrates, salt, or mineral licks are provided, except in the case of dairy cows.

Systems Combining Arable Cropping

Ruminant production systems combining arable cropping have evolved in situations where crop production is important to contribute to the stability of the system. Animals do not compete for the same land and play a supplementary role to arable cropping. Three types of systems are common: roadside, communal, and stubble grazing; tethering; and cut and carry feeding.

The three systems are not mutually exclusive. Grazing on roadsides and on communal (waste) land may be practiced by landless stock owners as well as others when their privately owned lands are under arable crop cultivation. Grazing in rice fields is restricted to periods immediately after harvest when the feeds available consist of the aftermath of the rice crop (i.e., rice stubble and some regrowth from the stubble), any weeds that grow in the paddies, the grasses that are found on paddy bunds, and browse from shrubs and trees that grow in it. Where multiple cropping is practiced, the crop aftermath may be burnt after the harvest and stubble grazing may be severely restricted or nonexistent.

Tethering is adopted when there is a need to prevent animals wandering into areas being cropped and to ensure that they graze down the available feed in a given area before they are moved. This type of confinement feeding is most popular in Southeast Asia because multiple cropping is widespread in this region. The animals may be tethered on waste grazing areas close to the farm or on rice fields after harvest to regulate stubble grazing or close to stacks of rice straw to allow self-feeding.

In the cut and carry system, a large proportion of the feed is usually brought in from outside the holding area because of the small size of holdings in relation to the number of animals kept. The system is subject to the vagaries of seasonal abundance and shortage of forage that characterize it. Because the livestock is housed most of the time, their growing dependence on high-priced concentrate feeds during lean periods increases.

The system together has had limited success because of the value of arable land for food production. This also presents a constraint to forage production for animals. The emphasis on crop production, however, makes large quantities of crop residues available, which are valuable as feeds, especially to ruminants.

The cut and carry or stall-feeding system requires high labour and capital investment. It is a system that favours situations where there is no land or, more particularly, the availability of abundant supplies of crop residues and agro-industrial by-products. Probably because of the higher capital investment, it has not been adequately used as a system. In Fiji, it has been reported that goats fed sugarcane crops, stovers, straws, coconut cake, rice bran, and molasses reached live weight of 23-25 kg in about 22 weeks with a daily live weight gain of 154 g, compared with 83 g in the extensive system (Hussain et al. 1983). Likewise in India, Sehgal and Punj (1983) have demonstrated the value of feeding 80 g NaOH/kg with wheat straw, which gave maximum growth rates in growing kids.

Where land is available for intensive pasture production, however, it is feasible to also produce meat or milk from small ruminants. Only limited work has been done in the Asian and Pacific region in this context, and to compare meat production from goats vs cattle, studies have been completed to investigate their response and grazing behaviour to cultivated Setaria setivalva pasture fertilized with 150 kg N, 40 kg P, and 40 kg K/ha per year applied in three equal amounts. The average yield of dry matter (DM) was about 5-6 t/ha. Four stocking rates were used: 20, 40, 60, and 80 goats/ha in a randomized block design, replicated three times, involving Katjang cross-bred kids with an initial live weight of about 10-12 kg. At the end of 4 months, the highest stocking rate rendered the paddock bare and this treatment had to be withdrawn.

The effect on daily live weight gain was dramatic (Table 6). Noticeable results occurred about 3 months after the experiment started, and the highest stocking rate only gave a daily live weight gain of 9.2 g/day per animal. Daily live weight gain was significantly correlated to body length ($r = 0.209$, $P<0.01$), height at withers ($r = 0.232$, $P<0.01$), and heart girth ($r = 0.306$, $P<0.01$). The results suggest that the optimum stocking rate for Setaria pastures is about 40 goats/ha.

Table 6. Effects of stocking rate on the performance of goats grazing Setaria sphacelata var. splendida pastures.

Parameter	Goats/ha			
	20	40	60	80
Mean live weight gain per animal (g/day)	43.2	41.2	29.0	9.2
Body length (cm)	103.3	102.5	99.4	99.3
Height at withers (cm)	53.2	53.2	52.0	51.1
Heart girth (cm)	59.1	59.5	57.7	56.4
Grazing time (min)	416.4	434.0	454.6	460.7
Resting time (min)	82.0	79.5	51.0	54.1
Distance walked (m)	852.1	664.4	813.3	801.3

Systems Integrated with Tree Cropping

This system can also be described under the intensive arable system, but it merits separate treatment, especially in view of the area under tree crops (coconuts, oil palm, and rubber) in South and Southeast Asia. More particularly, this is also justified by the fact that the system has considerable potential in increasing production from ruminants (Devendra 1985a) in view of the expanding hectarage under these tree crops.

This system is especially common in the humid and subhumid regions where this is intensive crop production. Although the system is not new, integration with these tree crops to ensure more complete utilization of the land has not been given adequate attention. The advantages of the system are

- Increased fertility of the land via the return of dung urine,

- Control of waste herbage growth,
- Reduced use of weedicides,
- Reduced fertilizer wastage,
- Easier management of the crop, and
- Distinct possibilities of increases in crop yields, consistent with greater economic including sale of animals and their products.

An additional advantage inherent in the system is the presence of abundant shade offered by the trees. This creates an environment that reduces heat stress on the grazing animals.

Given these advantages, and considering the large area under such tree crop as coconuts, oil palm, and rubber in some countries in Southeast Asia and the Pacific islands, the potential carrying capacity and offtakes of meat (goat meat or mutton or both) from the land is, therefore, enormous. Many of the Pacific island territories, notably Papua New Guinea, New Hebrides, Fiji, the Soloman Islands, and Western Samoa, have large land areas under coconuts, implying that there is much potential for integrating goats or sheep into them. Reynolds (1979) has reported the yields for various cultivated grasses and estimated the stocking rates for cattle. On the basis of 3% of body weight (20 kg) and assuming complete utilization of the available dry matter produced, the very high, high, medium, and low levels of production can support 64-73, 45-64, 34-45, and 34 goats or sheep/ha, respectively, which, in terms of biomass production, must rate very competitively with cattle production.

The potential for this kind of activity is reflected in an estimated area of 20.3×10^6 ha under tree crops in South and Southeast Asia (FAO 1984). In Malaysia, for example, the combined total hectarage under rubber and oil palm is about 4.3×10^6 ha. Even if only half of this crop area is utilized by animals, and assuming a carrying capacity of 3 animals/ha, the total number of animal equivalents is 5.2×10^6, which is substantial. A specific example of the economic benefits of integrating goats with oil palm concerns the case history of an oil palm estate that allocated a portion of the grazing land within the estate to the workers for grazing their animals. For the first 2 years (1980 and 1981), only cattle were owned and grazed; in 1982 and 1983, however, goats were also intro-

duced in addition to cattle. This was done in view of their economic importance and capacity to supply both meat and milk in the estate.

The comparison of the grazed and nongrazed area involving both young and mature trees is valid in that it involved the same area of 71-135 ha, and, more particularly, the fact that both areas were of the same soil type. The total cattle and goat populations were both about 80 and 220 animals, respectively. The differences in yield over the 4 years in favour of the effect of grazing cattle and goats was 2.15-5.16 t fresh fruit bunches per hectare per year with a mean value of 3.51 t of fresh fruit bunches per hectare per year (Table 7). When translated into the total hectarage grazed and sale value per tonne of fresh fruit yield, the economic advantage is substantial. The result in economic terms is similar to the findings in West Java of integrating goats and sheep with rubber (see Table 4). The presence of legumes is of definite advantage, and it has been calculated that the amount of N utilized by the animal and also excreted in the feces and urine increases with the presence of the legume cover (Table 8).

The value of small ruminants is also significant in the wider context of agroforestry systems. The complementary advantages are forage production, supply of fuelwood, improvement of soil fertility and permanent soil cover, and economic land use.

FUTURE TRENDS IN PRODUCTION SYSTEMS

With the prevailing patterns of animal production, and the resources currently being used to support them, ruminant production systems are unlikely to change (Mahadevan and Devendra 1985). It is the view of these authors that major shifts in resources use would be difficult unless returns from the new proposed systems are demonstrably superior. Changes must, therefore, be introduced gradually and must ensure income stability and low risk. The principal aim should be to make maximum use of the basic feed resources available, which is essentially crop residues or low-quality roughages or both. In addition, delivery systems should be developed for the essential supplementary feeds (leguminous forages, agroindustrial by-products, or other feed concentrates).

Table 7. Effect of mixed cattle and goat grazing on the yield of fresh fruits in an oil palm cultivation in Malaysia.

Year	Yield of fresh fruit bunches (t/ha)		
	Annual grazed area	Annual nongrazed area	Difference
1980	30.55 (cattle)	25.61	4.94
1981	17.69 (cattle)	15.87	1.82
1982	25.12 (cattle and goats)	22.97	2.15
1983	23.45 (cattle and goats)	18.29	5.16
Mean	24.20	20.69	3.51

Source: Devendra (1985a).

CONSTRAINTS TO PRODUCTION SYSTEMS

There are several critical constraints to the prevailing small ruminant production systems. It is essential to discuss these briefly and to keep them in perspective. It is important to stress that although individual constraints are identified, almost all of them are interrelated and, thus, have a variable effect on the production systems. Of these, the ecological constraints are largely uncontrollable, but their effects on the environment, and especially on the biological components such as animals and feeds, are significant. It is, therefore, more pertinent to consider the latter aspects. Sometimes, one constraint can dominate the presence of others. Feeding and nutrition, for example, can override the influence of reproductive efficiency and disease status of goats and sheep. The effects of disease status are less when nutrition is adequate.

Goat and Sheep Resources

There are a number of valuable indigenous goat and sheep resources widely adapted to the climatic extremes found in Asia. The adaptational characteristics are unique to the environment within which they perform a host of very valuable functions. Unfortunately, however, although considerable

Table 8. Utilization of three systems of ground vegetation by indigenous sheep under rubber in Malaysia.

Vegetation[a]	Dry matter (kg/ha)	Crude protein		N content (kg/ha)	N retained[b] (kg/ha)	N utilized (kg/ha)
		%	kg/ha			
NC	500	11.4	57	9.1	0.5	8.6
NC and legumes	1400	15.0	210	33.6	1.6	32.0
Pure legumes	2600	24.4	619	99.0	4.9	64.4

Source: Chee and Devendra (1981).
[a] NC, natural cover.
[b] A 70% digestibility of crude protein and a 7% retention of nitrogen by the grazing animal is assumed.

advances have been made to identify and describe the majority of these breeds (Acharya 1982; Devendra and Burns 1983; Hasnain 1985), their potential productive capacity has not been adequately investigated. Thus, in many instances, although the adaptational and functional values are apparent, their genetic potential remains largely unknown.

A major reason for this situation is the limitation on productivity imposed by the other constraints, notably feeding and nutrition, management, diseases, and health. Additionally, there are inadequate development policies and support services, the improvement of which can also enhance increased productivity.

Feed Resources

The overriding constraint in the production system is feed (Devendra 1986). There are three aspects to the problem. First, there is the issue of increasing the efficiency with which the available feeds are utilized. These include forages,

crop residues, agroindustrial by-products, and nonconventional feeds. It is suggested that prevailing feeding systems and the manner in which the feeds are used are inefficient, with the result that the productivity from both species is also low. Substantial improvements to feeding systems are, therefore, necessary in the quest to maximize productivity from small ruminants.

The second continuing problem is the inability to make maximum use of the total feed resources. Nonconventional feeds, which include several types of tree leaves, for example, are presently underutilized, despite the availability annually, of some 194 x 10^6 t in Asia and the Pacific (Devendra 1985b). It is significant to note that, of this total, about 93% of the feeds are suitable for feeding to ruminants.

The third aspect of this problem relates to inadequate supplies of feed such as those in Pakistan, India, and Indonesia, which severely curtail high performance. The objective here is to increase the feed supply on a year-round basis.

Management

Poor husbandry practices drastically reduce the response from goats and sheep and, therefore, reduce their productivity. Conversely, the effects of improved feeding and management on performance are spectacular and are seen in the results reported in goats in Malaysia (Devendra 1979) and goats in India (Sachdeva et al. 1973; Parthasarathy et al. 1983). In Fiji, improved husbandry, feeding, disease control, and breeding has been shown to increase the annual rate of reproduction from 120 to 180%, and well-fed does to produce their first kid within 12-13 months of age (Hussain et al. 1983). This is, therefore, an area that merits very much more attention than in the past in all types of integrated systems involving crops and animals as indicated in Table 5.

Diseases and Health

The wastage caused by disease represents a source of major economic loss in goats and sheep. These losses can be broken down into three categories:

- Lowered resistance, caused by undernutrition and malnutrition resulting in deaths by various diseases;

- Parasitism mainly caused by roundworm infestation is a major cause of loss throughout the tropics and is associated with poor nutrition and reduced resistance; and

- Transmissable diseases, such as coccidiosis and caseous lymphadenitis and pneumonia, are serious, cause high mortality, and necessitate disease monitoring, appropriate prophylactic measures, or vaccination.

Goats appear to be more susceptible to gastrointestinal parasitism than sheep. In Bangladesh, for example, 176 of 214 kids (82.2%) born died within 6 months; respiratory disorders, gastrointestinal parasitism, and contagious ecthyma were the main causes. In adults, 47.8% mortality was recorded for gastrointestinal parasitism and respiratory disorders (Abdur Rahman et al. 1976). Also, in Sri Lanka, kid mortality from 2340 pregnancies was reported to be 28% (Ranatunga 1971).

Products from Goats and Sheep

The inefficiencies that are apparent in the production systems result in the relatively low contribution from the species especially in terms of meat, fibre, and skins. This situation is consistent with the view that production of these commodities remains primarily a traditional enterprise. There is very limited commericial production of these same products, especially for markets such as in the Near East where there is a growing and large market preference for goat meat and mutton.

Clearly, improvements are necessary to the production process and include inter alia better use of the production resources (land, labour, and capital), incentives, credits, transportation, and market outlets. In this context, there is a need for cost-effective, commercial small ruminant production enterprises that can demonstrate the application of known technology and potentially profitable innovations. Such demonstrations encourage producers to invest in the enterprises.

Methodology

An additional constraint that is clearly an important prerequisite for efficient small ruminant production systems is methodology. The methodology must be of a type that can be applied successfully and can further stimulate expansion in small ruminant production.

This is especially the case with mixed crop - small ruminant systems, such as those that have been described in Table 5. If improvements are to be made within the totality of small farm systems in Asia, where mixed crops and animal systems are characteristic, an understanding is needed of the prevailing farming systems, the efficient use of the production resources, the injection of additional resources, and the requirements of the extention approach. De Boer (1985) suggests four consecutive stages: descriptive or diagnostic stage, design stage, testing stage, and the extension stage.

CONCLUSIONS

Small ruminant production systems in South and Southeast Asia are primarily traditional systems. Within these, goats and sheep occupy a secondary position in the complexity of small crop-livestock systems. The prevailing lack of incentives, inadequate understanding of the components of production systems, and, more particularly, inadequate application of potentially valuable technological interventions, suggests that a significant expansion in the productivity from goats and sheep is unlikely if the present trends are allowed to continue. Improvements are, therefore, urgently necessary and must efficiently use the production resources in systems that are demonstrably superior and potentially profitable. These improvements must be coupled to more intensive systems of production and to major shifts in resource use that can substantially increase the contribution by goats and sheep to the economy and food supply in the developing countries.

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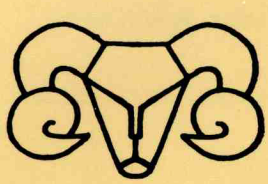

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Proceedings of a workshop held in Bogor, Indonesia, 6–10 October 1986

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Abstract This publication presents the results of a meeting held in Bogor, Indonesia, 6-10 October 1986, that focused specifically on the assessment of small ruminant production systems in South and Southeast Asia. It considered the prevailing circumstances, the innovations, and the strategies that are pertinent for stimulating increased productivity from goats and sheep. The present patterns of production were examined in detail with reference to characteristics of the small farms, existing management methods, and nature and components of the production systems. These systems include extensive systems, systems combining arable cropping, and systems integrated with tree cropping. The discussion of the systems were further highlighted by country case studies, issues and policies that considered the available production resources, especially the genetic and feed resources available, constraints to production, and potential means to achieve desirable improvements. An important session was devoted to examining research methodology, strategies for development appropriate to individual systems, and a conceptual framework for on-farm economic analysis. Together, these discussions enabled a definition of research protocols and the priorities for future direction that are likely to have a major impact on productivity from small ruminants.

Résumé L'ouvrage présente les conclusions d'une réunion tenue à Bogor, en Indonésie, du 6 au 10 octobre 1986, portant sur l'évaluation des systèmes de production touchant les petits ruminants en Asie du Sud et du Sud-Est. On y a brossé un tableau de la situation actuelle, des innovations et des stratégies susceptibles d'accroître la productivité dans l'élevage de la chèvre et du mouton. On a examiné en détail les méthodes actuelles de production dans la perspective propre aux petits exploitants, les éthodes actuelles de gestion, le type de systèmes de production et leurs éléments. Il s'agit ici des systèmes extensifs, des systèmes associant la culture des terres, et des systèmes intégrant la sylviculture. Les discussions ont été étayées d'études de cas, de problèmes et de politiques émanant des divers pays et portant sur les ressources disponibles pour la production, spécialement les ressources génétiques et fourragères, les contraintes à la production, et les possibilités d'amélioration qui existent. Une importante session fut consacrée à l'examen de la méthodologie de la recherche, des stratégies de développement convenant à chaque système, et d'un cadre conceptuel pour l'analyse économique des activités sur le terrain. Toutes ces réflexions ont permis de définir des plans de recherche et d'établir les priorités qui, dans l'avenir, auront vraisemblablement un impact majeur sur la productivité liée à l'élevage des petits ruminants.

Resumen Esta publicación presenta los resultados de la reunión celebrada en Bogor, Indonesia del 6 al 10 de octubre de 1986, cuyo temp principal fue la evaluación de los pequeños sistemas de producción de rumiantes en el

Sur y Sureste asiático. En la misma se analizaron las circunstancias imperantes, las innovaciones y las estrategias pertinentes para estimular la mayor productividad del ganado caprino y ovino. Se examinaron detenidamente los patrones actuales de producción con respecto a las características de las pequeñas granjas, a los métodos de manejo existentes y a la naturaleza y componentes de los sistemas de producción. Estos sistemas incluyen sistemas extensivos, sistemas que combinan el cultivo de tierras arables y sistemas integrados con plantaciones de árboles. La discusión de estos sistemas estuvo acompanada del análysis de etudios de casos en diferentes países, así como de problemas y políticas relacionados con los recursos de producción disponibles, especialmente los recursos genéticos y alimenticios disponibles, las limitantes de la producción y los posibles medios para obtener las majoras deseadas. Una importante sesión estuvo dedicada a examinar la metodología de las investigaciones, las estrategias para el desarrollo apropiadas para cada sistema individual, y un marco conceptual para la realización de análisis económicos en las granjas. En su conjunto, estas discusiones permitieron definir los protocolos de investigación y las prioridades para el futuro, que probablemente habrán de tener importantes repercusiones sobre la productividad de los pequeños rumiantes.

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